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Review Article

A Pharmacognostic and pharmacological overview on *Bombax ceiba*

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Abstract: Bombax ceiba is commonly known as silk cotton tree and semal which belongs to family Bombacaceae. *Bombax ceiba* is an important medicinal plant of tropical and subtropical India. Its medicinal usage has been reported in the traditional systems of medicine such as Ayurveda, Siddha and Unani. It has wide range of medicinal and pharmacological application. It is used in tradition system of medicine and exibits diuretic, dysenteric, emetic, diarrhoeal, Wounds, Acne, skin blemish and pigmentation, Cold and cough. It has many pharmacological activities like In-vitro Anti-inflammatory, Anti-diabetic, Anti-obesity, Hypotensive, Antioxidant, Antiangiogenic, Antimicrobial, Cytotoxicity, Aphrodisiac and Antipyretic. This paper provides an overview on pharmacological, phytochemical properties and therapeutic benefits of the plant.
Keywords: *Bombax ceiba,* In-vitro Anti-inflammatory, Anti-diabetic, Anti-obesity, Antiangiogenic, Hypotensive.

INTRODUCTION

Bombax ceiba is commonly known as silk cotton tree and semal which belongs to family Bombacaceae. It is one of the important medicinal plants in tropical and subtropical India and also occurs in Sri Lanka, Pakistan, Bangladesh, Myanmar, Malaysia, Java, Sumatra and Northern Australia. It has number of traditional uses and its medicinal usage has beenreported in the Indian traditional systems of medicine such as Ayurveda, Siddha and Unani [1]. It is known by different names such as Red cotton tree, Indian kapok tree (English), shalmali (Sanskrit), semal (Hindi), shimul (Bengali), mullilavu (Malyalam), kondabruga (Telgu) , in different languages [2]. Bombax ceiba- "Bombax" (Greek) = silkworm; "ceiba" south American vernacular name for silk cotton tree [3]. According to Ayurveda, it has stimulant, astringent, haemostatic, aphrodisiac, diuretic, antidiarrhoeal,cardiotonic, emtic, demulcent, antidysenteric, alterative, and antipyretic properties [4-5]. It is widely found in temperate Asia, tropical Asia, Africa and Australia. In India, it can be found at altitudes upto1500 m. In peninsular India, the tree is very common inthe dry as well as moist deciduous forests and near rivers. The tree is a strong light-demander and fast growing. It grows best on deep sandy loams or other well-drained soils, particularly in valleys, in regions receiving 50 to 460 cm annual rainfall well distributed throughout the year [6].

BOTANY

Red silk cotton tree (Bombax ceiba) is a tree with "a very striking feature in any landscape where it occurs, in the months of December, when it loses its foliage, and January, when it bursts into a blaze of scarlet flowers upon the naked branches" [7].

HISTORY

Tin 'Mahabharata' it is related to 'Pitamaha' after having created the world, reposed under the tree 'Salmali'. In the 'Yajnavalkya' it is mentioned as one of the trees of the infernal regions. Roots of very young tree have astringent, aphrodisiac and alterative properties. In Holland, the gum is used as an astringent. In Madras, the young fruits are dried and used as a demulcent and astringent. Also the gum is used in diarrhoea and dysentery [8].

DESCRIPTION

A large deciduous tree with tall trunk and spreading crown. Trunk and branches, particularly of young trees covered with large woody conical prickles. Leaves large, leaflets 3-7, palmately arranged, 15-30 cm long; petiole longer than the leaflets. Flowers large, yellow to bright red, numerous, fascicled at the end of the branches, appearing before the new leaves. Fruit 15-17.5 cm, oblong-obtuse, 5-valved, lined within with white silky hairs [9].

Fig. 1: *Bombax ceiba* tree

TAXONOMICAL CLASSIFICATION [12]

Rank	**Scientific Name and common Name**
Kingdom	Plantae – Plants
Subkingdom	Tracheobionta – Vascular plants
Superdivision	Spermatophyta – Seed plants
Division	Magnoliophyta – Flowering plants
Class	Magnoliopsida – Dicotyledons
Subclass	Dilleniidae
Order	Malvales
Family	Bombacaceae – Kapok-tree family
Genus	*Bombax* L. – cottontree
Species	*Bombax ceiba* L. – red silk cotton tree

Table 1: Floral characters of *Bombax ceiba* [10]

Floral character	**Observation**
Flowering period	January–March
Flower type	Somewhat ornithophilous
Flower colour	Crimson
Odour	Absent
Nectar	Present
Flower opening time	Post midnight to morning
Anther dehiscence time	After anthesis
Anther dehiscence mode	Longitudinal
Number of anthers	Many (100 approx.)
Average number of pollens per anther	88,630
Average number of pollens per flower	88,63,000
Pollen type	3-colporate
Pollen shape	Euoblate
Pollen size	± 38.8 ´ 71.75 µm
Atmospheric pollen frequency	5.17% in 10.00 h
Stigma type	Above anther level, digitate with stout style and wet type

DISTRIBUTIONAL RANGE

Asia-Temperate

China: China -Fujian, Guangdong, Guangxi, Guizhou, Jiangxi, Sichuan, Yunnan

Eastern Asia: Taiwan

Asia-Tropical

Indian Subcontinent: Bhutan; India; Nepal; Sri Lanka

Indo-China: Cambodia; Laos; Myanmar; Thailand; Vietnam

Malesia: Indonesia; Malaysia; Papua New Guinea; Philippines

Australasia

Australia: Australia - Northern Territory [n.], Queensland [n.], Western Australia [n.][11].

PHYTOCONSTITUENTS

Bombax ceiba flowers have been shown to contain the β-Dglucoside of β-sitosterol, free β-sitosterol, hentriacontane, hentriacontanol, traces of an essential oil, kaempferol, and quercetin [13]. Shamimin, a newly discovered flavonol C-glycoside has been isolated as a pale yellow powder from the ethanolic extract of fresh, undried leaves of B. ceiba. Its structure has been elucidated as 2-(2, 4, 5-trihydroxyphenyl)-3, 5, 7-trihydroxy-6-C-glucopyranosyloxy-4H-1-benzopyran-4- one through extensive spectroscopic methods (IR, mass, 1H- and 13C-NMR), and 2D-NMR experiments [14]. The Ph.D work presented by Muhammad Ali Versiani reviewed the phytochemical studies of B. ceiba. Dried leaf extracts of the plant were subjected to chemical investigation, which led to the isolation of three new compounds [4-C-β-D Glucopyronosyl-1, 3, 6, 8-tetrahydroxy- 7-O-(4”-hydroxybenzoyl)-9H-xanthen-9-One (I), 2-C-β-D Glucopyronosyl-1, 6, 7-trihydroxy-3-O-(4”-hydroxybenzoyl)- 9H-xanthen-9-One (II), 4-C-β-D Glucopyronosyl-1, 6, 8-trihydroxy-3, 7-di-O-(4”-hydroxybenzoyl)-9H-xanthen-9-One (III)] and one known compound mangiferin [15]. A sesquiterpene lactone isolated from the roots of a plant species identified as Salmaliamalbaricum(synBombax ceiba) was previously identified as hemigossylic acid lactone-7- methyl ether. 2D NMR experiments have shown that this was a new compound, isohemigossylic acid lactone-2-methyl ether [16]. A detailed exploration of phytochemical properties along with the TLC ratios of various extracts of B. ceiba was also conducted which showed that the alcoholic and water extracts indicate the presence of alkaloids, flavonoids, glycosides, coumarins, proteins and amino acids [17]. Phytochemical investigation was carried out on the gynaceum part of the flower of B. ceiba plant. Chromatographical techniques were employed to isolate the compound quercetagetin glycoside from the ethyl acetate fraction of an ethanolic extract of the gynaceum part of the flowers.The structure of the isolated compound was elucidated by spectroscopic methods including UV, 1H and 13CNMR [18]. Isolation and characterization resulted in the identification of two compounds from the extracts of stem barks of B. ceiba. These were lup-20 (29) en-3b-ol, named BC-1 and 2-hexyl-7, 8-dimethyl-1, 4-naphthaquinone, named ceibanaphthaquinone [19].

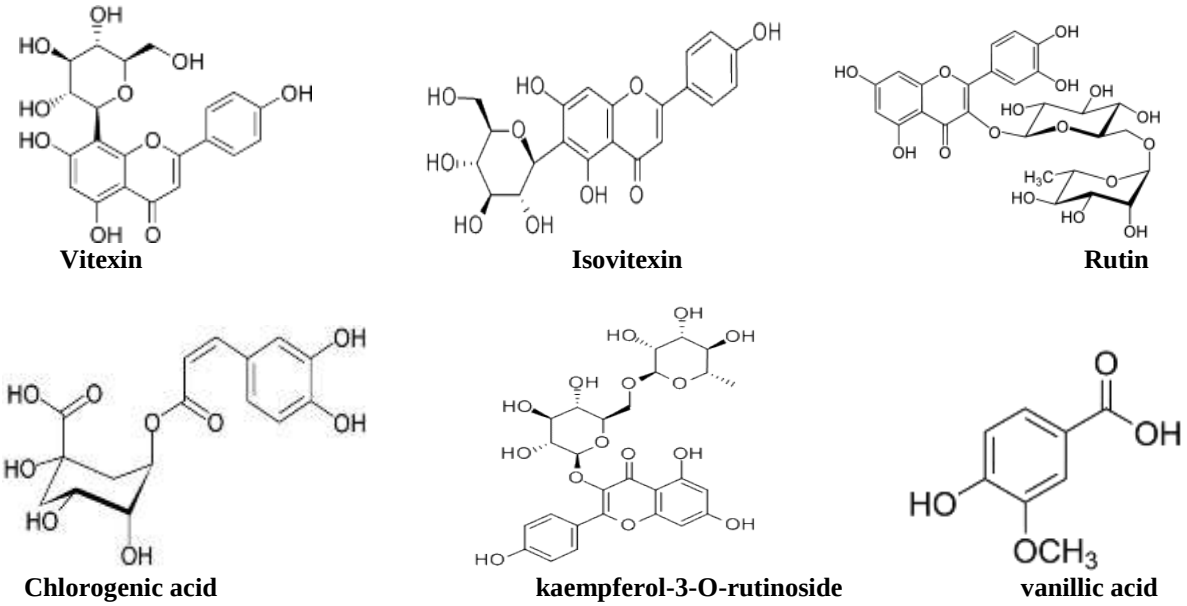

Fig. 2: Phytoconstituents *Bombax ceiba*

The structures of these compounds were elucidated by spectroscopic analysis and comparison with literature data as: quercetin-3-O-β-D-glucuronopyranoside, chlorogenic acid [20], rutin [21], sexangularetin-3-O-sophoroside [22], vitexin, isovitexin [23] vicenin 2 [24], kaempferol-3-O-rutinoside [25],

kaempferol-3-O-β-D-glucuronopyranoside, isomangiferin and 7-O-methyl mangiferin [26], esculetin [27], scopoletin [28], fraxetin [29], scopolin [30], blumenol C glucoside [31], benzyl-β-Dglucopyranoside [32], phenylethylrutinoside [33], protocatechulic acid [34], methyl chlorogenate [35], and vanillic acid [36]. Of these, were isolated from this plant.

MEDICINAL USES

Nocturnal emission, semen problems

Take semal root powder and add vidari (Ipomoea digitata) root, shatawar and misri. Take twice a day with milk.

Blood purification

Take leaves of semal and grind with water. Filter and drink.

Leucorrhoea

Take semal root powder twice a day with water.

Over bleeding in menstruation

Mix semal root powder (100 gm), mulethi powder (50 gm), swarngeru (25 gm). Take this powder powder twice a day with water or milk.

Acne, skin blemish and pigmentation

Take thorny part from stem of semal tree. Make paste of root of thorn with water. Apply on affected area. This also lightens scar marks due to boils, freckles, acne vulgarise and burns.

Wounds

Apply paste of its bark on wound.

Weakness

From the semal flower take green base part, clean and dry in shade. Grind to make powder. Mix one spoon powder, honey (2 tbsp) desi ghee (1 tbsp) in milk and drink.

Improve breast milk

Take bark of semal root, clean and dry and grind to make powder. Take twice to improve breast milk.

Cold and cough

Mix semal root powder with black pepper and dry ginger powder. Take in small amount to cure cold and cough [37].

PHARMACOLOGICAL ACTIVITIES

In-vitro Anti-Inflammatory Activity

In-vitro anti-inflammatory activity of extracts of B. ceiba was assessed by Human Red Blood Corpuscles (HRBC) membrane stabilizing method with slight modifications. The blood was collected from healthy human volunteer who had not taken any anti-inflammatory drugs for 2 weeks prior to the experiment and transferred to the heparinized centrifuge tubes and centrifuged at 3,000 rpm. The packed cells were washed with isosaline and a 10% suspension in normal saline was made. Diclofenac potassium (50 mcg/ml) was used as standard. The reaction mixture (4-5 ml) consisted 2 ml of hypotonic saline (0.25% w/v NaCl), 1 ml of 0.15 M phosphate buffer (pH 7.4), 1 ml of test solution (1000 mcg/ml) in normal saline and 0.5 ml of 10% HRBC in normal saline. For control, 1 ml of isotonic saline was used instead of test solution. The mixtures were incubated at 56ºC for 30 min. and cooled at running tap water, centrifuge at 3000 rpm for 20 min. The absorbance of supernatant was read at 560 nm using visible Spectrophotometer. The experiment was performed in triplicates. The control represents 100% lyses [38].

Anti-obesity

The extract of stem bark of *Bombax ceiba*Linn.has significant anti-obesity potential against HFD induced experimental obesity, possibly due to modulation of FAS and PTP-1B signaling in Wistar rats due to the presence of active flavanoids and lupeol respectively [39].

Anti-diabetic activity

A dose of 600 mg/kg of B. ceiba extract is the most effective to cause significant ($p<0.001$) hypoglycemic and/or hypolipidemic effects on streptozotocin-induced diabetic rats. This dose also significant-ly ($p<0.001$) lowered the total cholesterol and triglyceride level in severely diabetic rats. Phytochemical and GC-MS studies confirmed the presence of the triterpenoid compounds in the extract, which may account for its significant hypoglycemic activity. The present study thus provides a scientific rationale for the traditional use of this plant in the management diabetes [40].

Hypotensive activity

Shamimin along with lupeol [lup-20 (29) en-3b-ol], which possesses potent hypotensive activity, have been isolated from B. ceiba stem bark. BCBMM [filtrate from BCBM (Methanolic extract of defatted stem bark)] one of the most active fractions has revealed its adverse effects on heart, liver and kidneys of mice at the dose of 1000 mg/kg/d [41].

Antioxidant activity

The antioxidant activity of a methanolic extract of B. ceiba was evaluated using several antioxidant assays, in terms of its: (i) ability to scavenge DPPH (1, 1-diphenyl-2-picryl-hydrazyl) and hydroxyl free radicals; (ii) action against lipid peroxidation (in rat liver microsomes and soy bean phosphatidylcholine liposomes), induced by ascorbyl radicals and peroxynitrite; and (iii) effect on myeloperoxidase activity. The cytotoxicity was monitored through the mitochondrial activity in the Vero cell line. The extract showed antioxidant activity in all assays. The EC (50)

for DPPH was 87 µg/ml; lipid peroxidation of microsomes and soy bean liposomes induced by ascorbyl radicals were 141 µg/ml and 105 µg/ml, respectively, and by peroxynitrite were 115 µg/ml and 77 µg/ml, respectively. The K (0.5) value for myeloperoxidase activity inhibition by the extract was 264 µg/ml. The extract showed very low toxicity toward Vero cells [42].

The total phenolic content present in water extracts of B. ceiba (elaimbul; gum), was determined by Folin-Ciocalteu method. Caffeine and gallic acid were quantified by high performance liquids chromatography (HPLC). Total free radical scavenging activity of each ingredient was investigated by 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging method and the values were compared with phenolic and gallic acid present in each plant. The polyphenol content of B. ceiba were 32.57 ± 5.04% of total extractable. Detectable levels of gallic acid were present only in B. ceiba (1.46 mg/g of total extractable). The EC_{50} values for DPPH radical scavenging activity for B. ceiba were 15.47 ± 1.80 µg cm^{-3}, The mean values of EC_{50} (y) for DPPH radical scavenging activity were correlated with total phenolics (x) present in plant extracts (y = -35.417x + 1428; R = 0.9887) [43].

Analgesic activity

Mangiferin, 2-beta-D-glucopyranosyl-1,3,6,7-tetrahydroxy-9H-xanthen-9-one, obtained directly from methanolic extracts of B. ceiba leaves demonstrated strong antioxidant activity (EC(50) 5.8 (+/-) 0.96 mµg/ml) using DPPH assay. The acetyl and cinnamoyl derivatives were found to be less active than mangiferin whereas methyl and 3, 6, 7-trimethylether tetraacetate derivatives were inactive implying that for antioxidant activity, free hydroxyl groups and catechol moiety are essential. Moreover, mangiferin showed hepatoprotective activity against carbon tetrachloride induced liver injury further supporting the free radical scavenging property in the in vivo system. Additionally, crude plant extracts and purified mangiferin failed to exhibit acute anti-inflammatory activity whereas, extracts displayed significant analgesic effect in acetic acid-induced writhing and hot plate tests in mice. Using naloxone, it was revealed that plant extract induced analgesia was independent of the opioid receptor; whereas, mangiferin demonstrated significant interaction with the receptor at a peripheral site, with a slight contribution at the neuronal level [44].

Antiangiogenic activity

A methanol extract of the stem barks of B. ceiba was found to exhibit a significant antiangiogenic activity on in vitrotube formation of human umbilical venous endothelial cells (HUVEC).Bioactivity-guided fractionation and isolation carried out on this extract identified lupeol as an active principle. At 50 and 30 µg/ml, lupeol showed a marked inhibitory activity on HUVEC tube formation while it did not affect the growth of tumor cell lines such as SK-MEL-2, A549 and B16-F10 melanoma [45].

Hypotensive and hypoglycaemic activity

Shamimin, a C-flavonolglucoside from B. ceiba leaves showed significant potency as a hypotensive agent at the doses of 15 mg/kg, 3 mg/kg, 1 mg/kg and significant hypoglycaemic activity at 500 mg/kg in Sprague Dawley rats [46].

Antimicrobial and antibacterial activity

Plant extracts (methanol and aqueous) were assayed for their activity against multi-drug resistant Salmonella typhii. Strong antibacterial activity was shown by the methanol extracts of Salmaliamalabarica [47].

Plant or plant parts were collected, dried, homogenized and extracted in two organic solvents viz. methanol and acetone. The antibacterial activity against Klebsiellapneumoniae was done by agar disc diffusion method. The activity was compared with standard antimicrobials Amikacin and Piperacillin [48].

Cytotoxicity

Aqueous extracts of the plants were screened for their cytotoxicity using the brine shrimp lethality test [49]. The present study supports that brine shrimp bioassay is simple reliable and convenient method for assessment of bioactivity of medicinal plants and lends support for their use in traditional medicine

Hepatoprotective activity

The hepatoprotective activity of a methanolic extract of flowers of B. ceiba (MEBC) was investigated against hepatotoxicity produced by administering a combination of two anti-tubercular drugs isoniazid (INH) and rifampicin (RIF) for 10 and 21 days by intraperitoneal route in rats. MEBC were administered at three graded dose i.e. 150, 300 and 450 mg/kg i.p. 45 min prior to anti-tubercular challenge for 10 and 21 days. MEBC was evident in all doses as there was a significant decrease in alkaline phosphatase (ALP), alanine transaminases (ALT), aspartate transaminases (AST) and total bilirubin levels, but increase in the level of total protein in comparison to control. MEBC significantly decreased the level of TBARS (thiobarbituric acid reactive substances) and elevated the level of GSH (reduced glutathione) at all doses as compared to control. The results obtained from the analysis of biochemical parameters and histopathological studies, resulted in the conclusion that the MEBC were not able to completely revert the hepatic injury induced by INH and RIF, but it could limit the effect of INH and RIF to the extent of necrosis [50].

Inhibitory effects on fatty acid syntheses

Fatty acid syntheses (FAS) had been found to be over express and hyperactive in most cancers [51]. Pharmacological inhibitors of FAS activity preferentially repress cancer cell proliferation and induce cancer cell apoptosis without affecting nonmalignant fibroblasts. These made FAS an excellent drug target for cancer therapy. The FAS activity is the lowest in gastric cancer cell N87 (15.91 ± 3.61 U/mg protein) and the highest in lung cancer cell A549 (127.36 ±10.14 U/mg protein). The cancer cell A549 was used as a cell model to test the inhibitory effort of flavonoid extracts on FAS. The minimum inhibitory concentration of B. ceiba Linn was 247.98 µg/ml [52].

Antipyretic

The methanol extract of Bombax malabaricum (syn Bombax ceiba) leaves (MEBM) was investigated for the antipyretic activity in rats [53]. MEBM possessed significant antipyretic activity in Baker's yeast-induced pyrexia. Phytochemical tests showed the presence of steroids, carbohydrates, tannins, triterpenoids, deoxy-sugars, flavonoids and coumarin glycosides.

Aphrodisiac

The aphrodisiac activity of *B. ceiba* root extract was investigated. The extract (400 mg/kg body wt/day) was administered orally by gavage for 28 days. Mount latency (ML), intromission latency (IL), ejaculation latency (EL), mounting frequency (MF), intromission frequency (IF), ejaculation frequency (EF) and post-ejaculatory interval (PEI) were the parameters observed before and during the sexual behaviour study at day 0, 7, 14, 21, and 28 days. The extract reduced significantly ML, IL, EL and PEI ($p < 0.05$). The extract also increased significantly MF, IF and EF ($p < 0.05$). These effects were observed in sexually active and inactive male mice [54].

CONCULSION

Red silk cotton (*Bombax ceiba*) is a tree. It is one of the important medicinal trees in tropical and subtropical India and also occurs in Sri Lanka, Pakistan, Bangladesh, Myanmar, Malaysia, Java, Sumatra and Northern Australia. It's having lots of medicine use. Semaltrees are useful in the treatment of diuretic, dysenteric, emetic, diarrhoeal, Wounds, Acne, skin blemish and pigmentation, Cold and cough**.** Bombax ceiba having different pharmacological activities likeIn-vitroAnti-inflammatory, Anti-diabetic, Anti-obesity, Hypotensive, Antioxidant, Antiangiogenic, Antimicrobial, Cytotoxicity, Aphrodisiac and Antipyretic. This review article is reestablished various properties of "Bombax ceiba" and pharmacological activities of tree with various phytochemical constituents such as vitexin, isovitexin, chlorogenic acid, rutin, hentriacontanol, sitosterol, kaempferol-3-O-rutinoside, isomangiferin, vanillic acid, protocatechulic acid and other constituents.

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